

Two new species of anchialine amphipod (Crustacea: Hadziidae: *Liagoceradocus*) from Western Australia

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Abstract – Two new species of *Liagoceradocus*, *L. subthalassicus* and *L. branchialis*, from anchialine habitats (hypogean waters of marine origin) are described from Barrow Island and North West Cape, Western Australia.

INTRODUCTION

It is becoming clear that the systematic boundary between amphipods inhabiting epicontinental waters and coastal marine waters in Australia is indistinct. Whilst there are many species in genera and families confined to or characteristic of inland fresh waters, there are also many species which, though found in Australian fresh waters, belong to genera or families of typically marine habit or which display many taxonomic features linking them with marine ancestors (see, for example Barnard and Williams 1995). The occurrence in Australia of undoubted marine forms in waters of essentially oceanic origin located inland but at no great distance from the coast is not therefore unexpected. The problem, however, is how best to treat them in revisions of the Australian amphipod fauna: as epicontinental species, or marine species *sensu stricto*? In the event it has been considered best to treat them separately and not to regard them as an integral part of the Australian inland aquatic amphipod fauna.

In recent collections from anchialine sites on Barrow Island (20°46'S, 115°24'E), and North West Cape (22°25'S, 113°46'E), Western Australia, we located specimens of the marine genus *Liagoceradocus*. Description of these specimens form the basis of this paper, and the new species described herein (*L. subthalassicus* and *L. branchialis*) are not regarded as members of the amphipod fauna of Australian inland waters. For this reason they are not included in our series of papers reviewing this fauna, but dealt with separately.

Methods of description follow those of Williams and Barnard (1988) except that L represents left and R, right. All specimens are lodged in the Western Australian Museum, Perth (WAM).

Genus *Liagoceradocus* Barnard

Liagoceradocus Barnard, 1965: 504.

Remarks

The genus *Liagoceradocus* Barnard, 1965 was erected for a pair of specimens taken from Ifaluk Atoll, Caroline Islands. Six species have so far been assigned to the genus, all from interstitial and subterranean marine waters of the tropical Pacific ocean. Rondé-Broekhuizen and Stock (1987) considered *Liagoceradocus* a viable genus distinct from *Hadzia*, whereas Stock and Iliffe (1991) considered it a doubtful genus because of the poor initial description of the type, and poor condition of the types. Stock and Iliffe (1991) questioned the assignation of other species to the genus on the grounds of the unique maxillipedal palp and distinct, spine-less palm of the second gnathopod of *Liagoceradocus pusillus* Barnard 1965. Barnard (1977), when assigning a second species to the genus, reduced the status of *Liagoceradocus* to a subgenus of *Hadzia*, although the genus was maintained by Barnard and Barnard (1983). Nevertheless, subsequent species have been attributed to *Liagoceradocus*. Stock and Iliffe (1991) themselves added a further two species despite the concerns expressed above. Furthermore, they noted that sexual dimorphism of the third pleopod was evident in some species while absent from others (although they suggested this may have been a reflection of lack of adult males among collections, whilst in some descriptions pleopods were not fully described). However, inconsistency of sexual dimorphism has not necessarily been regarded as contrary to generic compatibility. Williams and Barnard (1988) reported species of *Neoniphargus* may or may not display sexual

dimorphism in both the possession of antennal calceoli and of notched gnathopodal palms.

In this paper we accept *Liagoceradocus* as a valid genus and ascribe two new species to it: *L. subthalassicus* and *L. branchialis*. The presence of the genus in the Indian Ocean considerably extends its known area of distribution.

Liagoceradocus subthalassicus sp. nov.

Figures 1–3

Material Examined

Holotype

♀ 3.5mm. Unique (WAM 258-95, collection BES546).

Type locality

Ledge Cave B-1, an anchialine cave on Barrow Island, Western Australia, Australia (20°48'S, 115°20'E), collected by trapping, 28 July 1992, W.F. Humphreys and B. Vine.

Diagnosis

Pleonites naked except for 3 small dorsal setae on pleonite 4. *Head*. Rostrum weak, lateral cephalic lobes moderately projecting, antennal sinus small and distinct, eyes absent. *First antenna* elongate, longer than A2, ratio of peduncular articles 23:21:11, accessory flagellum 2 articulate, no calceoli. *Second antenna* short, flagellum much shorter than peduncle, calceoli absent. *Upper lip*. Apical margin rounded, symmetrical. *Mandible*. Palp 3 articulate, ratio of articles 17:39:41, article 1 not setose, article 2 bearing 4 strong medial setae, article 3 sub-falciform, almost linear, setate, approximately equal in length to article 2, setae = D9,E4. Accessory blades (rakers) = 9, without inter-raker plumose setae but 1 additional short naked seta proximally. No additional serrations beyond rakers. *Lower lip* bearing small vestigial inner lobes. *Maxillae* moderately setose medially. *First maxilla* inner plate triangular or semi-circular, linear medially, with 12 plumose medial setae, outer plate with 7 spines, palps asymmetric, both plates well covered in pubescence. *Second maxilla* inner plate with oblique facial row of long setae, baso-medial and outer-distal margins, and apical margin of the outer plate pubescent, both plates with moderate to strong apical setae. *Maxilliped*. Inner plate long, extending beyond M0.5 of the outer plate, laterally pubescent, with a distal row of 5 plumose setae, 3 blunt naked tooth spines, 1 sub-distal medial spine on the left side only, and 1 sub-marginal sub-distal medial spine forming a short row with 2 long plumose setae at M0.5 and M0.7. Outer plate broad with 5 naked and 2 plumose distal setae, 2 strong, short distal sub-marginal medial tooth spines, the

disto-medial margin carved into 2 or 3 acuminate sinuosities merging basally with a medial row of 8 slender spines which become sub-marginal distally leaving the sinuosities naked. Palp article 2 without lateral setae, article 3 with a single lateral seta at M0.9, and 2 pairs of latero-facial setae at M0.4 and M0.7, articles 2–3 moderately setose medially, article 3 bearing a transverse band of pubescence at M0.5, and distal comb rows of setae toward the base of the dactyl, the apex is moderately produced, dactyl unguiform with 3 distal accessory spinules, the nail of moderate length, bearing a single dorsal spinule of equal length. *Coxae*. C1–3 longer than broad, C4 as broad as long, C1–4 with few posterior spines, C1 not expanded below, C4 not excavate posteriorly. *Gnathopods* subchelate, 1–2 diverse. Setae of articles 4 ordinary, not rastellate. *First gnathopod* small, feeble, carpus longer than propodus, not lobate, merus not lobate but posteriorly bulbous and pubescent, left palm slightly oblique, right palm transverse, both short, palmar spines not symmetrically bifid but with small sub-apical trigger like extensions. Spines at corner of palm = 2 stout bifid medial and lateral, and 1 elongate, slender, lateral. Few spines or setae along the palm, dactyls lacking recumbent inner tooth spines, nail present. *Second gnathopod* enlarged, 2x G1, carpus equal to propodus, with long keel like pubescent posterior lobe, posterior setae sub-marginal proximally, to facial distally, hand ovate, palm oblique, moderately spinose and setulose, defining corner with 2 stout medial spines and 2 elongate lateral spine-setae, nail absent, free posterior margin bearing long 'hadziid' setae (Barnard and Barnard, 1983). *Pereopods* feeble, weak. P3–4 smaller, weaker than P5–7, posterior spine sets on article 6 of P3–4 weak, uneven. P5–7 moderately elongate, P7 longest, P5 shortest, article 2 moderately expanded, ovate, slightly lobate on P6, lobate on P7. Dactyls of P3–7 bearing 2 or more distal accessory spinules as well as an outer basal penicillate setule. *Gills*. Coxae 2–6 each with a single flask shaped gill. Gill 6 not reduced. *Oostegites*. Coxae 2–5 each bearing a thin, poorly setose oostegite.

Epimera. Posteroventral tooth of E1–3 absent except for a tiny spine on E3. Posterior margins smooth and naked except for 1 or 2 small setae. E2–3 with single, small posterior ventro-facial spinules and 1 or 2 antero-facial spines. *Pleopods* with dissimilar numbers of setae and retinacula. Rami extending sub-equally and symmetrically, baso-medial setae not bifid. *Urosome*. With 3 ventro-distal spines on urosomite 1 at the base of U1. *Uropods*. U3 extended, magniramous, dispariramous, peduncle short, outer ramus 2 articulate. Apico-lateral corner of peduncles of U1–2 with 1 spine, the dorsal margins spinose, medial margin of peduncle of U1 with 1 apical spine, of

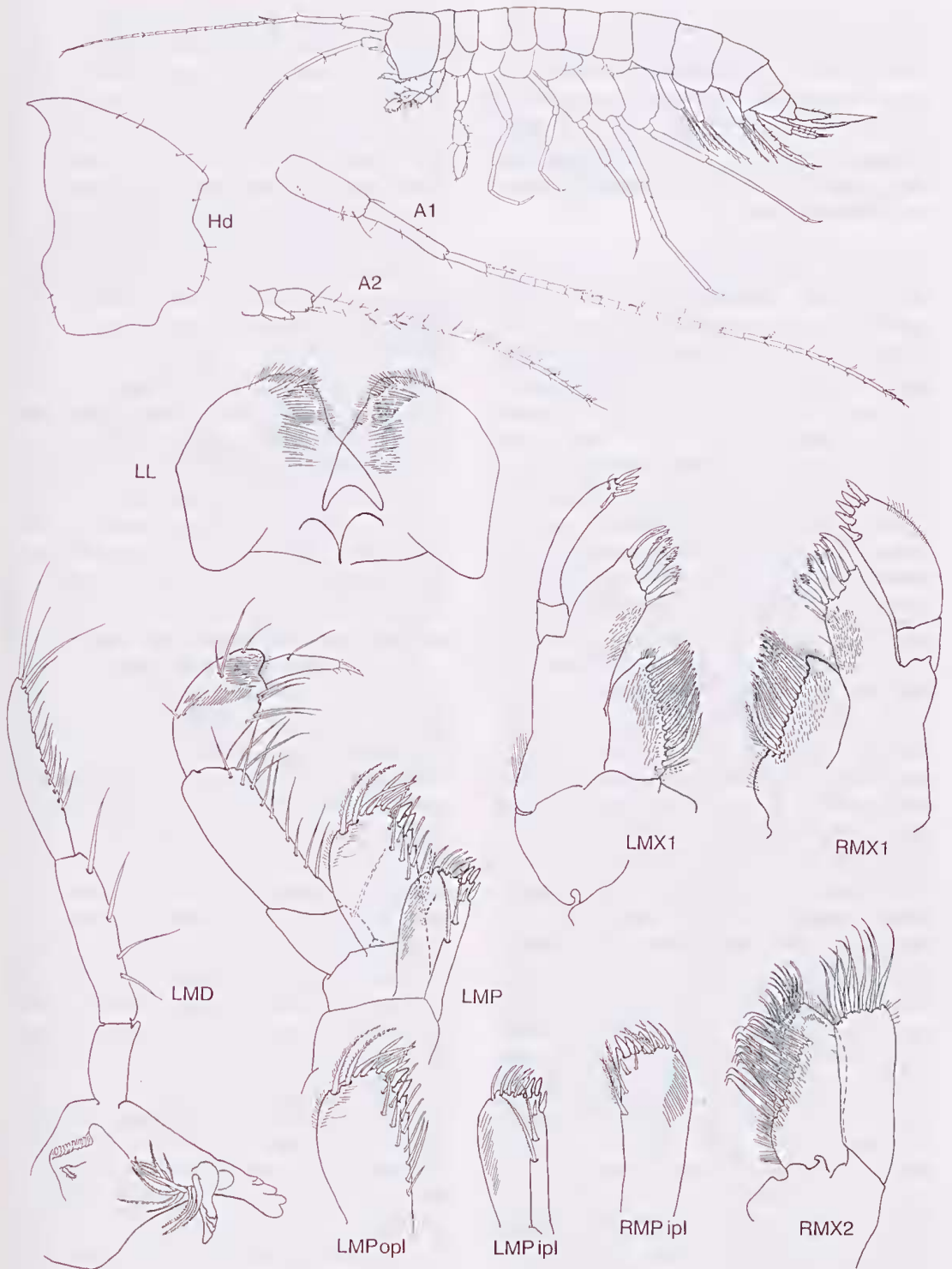


Figure 1 *Liagoceradocus subthalassicus* sp. nov., holotype, female 3.5 mm. Whole animal, head, antennae and mouthparts.

U2 with 4. Rami sub-equal, the lateral being the shorter. Peduncle of U1 with baso-facial spine. Rami of U1-2 with single spine rows. Medial setae of outer ramus of U3 present as 3 distal pairs, sub-distal peduncular setae and spines absent, rather a pair of mid-distal spines at the base of the outer ramus. *Telson* longer than broad, cleft 100%, lobes moderately convex laterally, linear medially, with sub-apical setation, medial and lateral setal spines. Penicillate setules absent.

Description of holotype (female)

Body 3.5 mm. (Figure 1). Poorly armed dorsally. *Head*. Rostrum weak, lateral cephalic lobes moderately projecting, antennal sinus small, distinct, eyes absent. *First antenna* (Figure 1) length 0.75X body. Flagellum longer than peduncle - 1.8x (98:53) - peduncular article 1 longest, bearing a long strong medio-distal seta, article 3 shortest (ratio of lengths; 230:210:110), setae sparse, accessory flagellum 2 articulate, reaching M0.4 of article 2 of primary flagellum, 2nd article reduced - 4:11 of article 1. Primary flagellum of 23 articles, uniform, sparsely setulate, aesthetascs present on articles 6,7,9,15,18,21,22, calceoli absent. *Second antenna* (Figure 1) length 0.4x body, peduncle longer than flagellum (130:76), gland cone well developed and extending to M0.5 of the third article, peduncular article 3 with few setae or spines, articles 4-5 equally long, slender, moderately setulate. Flagellum 7 articulate, calceoli absent. *Upper lip* (Figure 1). Apical margin rounded, symmetrical, with short marginal pilia. *Lower lip* (Figure 1). Inner lobes small, basal. *Mandibles* (Figure 1). Similar, palp article 1 shorter than 2, articles 2-3 equal, article 3 with 9D and 4E setae, incisor 4 toothed, lacinia mobilis with 4 teeth, the fourth denticulate, 9 setose accessory blades, molar bearing a very short minutely setulate distal seta. *Maxillae* (Figure 1). Right and left palps of *first maxillae* asymmetric; 5 apical tooth spines on the right palp, 4 slender apical spines and 2 accessory sub-apical spines on the left. The outer plate bearing 6 denticulate apical spines and a single slender 7th medio-distal spine on the left, the right outer plate bearing 7 denticulate or barely denticulate apical spines and a single moderate, naked, medial, sub-apical spine. Inner plate with 12 (right) or 13 (left) medial plumose setae. *Second maxilla*, both plates with outer apical margin pubescent. Inner plate with baso-medial pubescence extending across the face basal and distal to an oblique row of setae forming a sub-apical pubescent crescent. The outer plate with few medial and several apico-medial setae. *Maxilliped* (Figure 1). Inner plate without ventro-facial spines. *First gnathopod* (Figure 2) coxal plate with short setae ventrally not extending beyond the posterior corner. Article 5 not lobate, propodus trapezoidal,

expanding slightly apically, longer than wide (78:52), the corner of the left palm marked with 1 lateral and 1 medial strong bifid spine and a single moderate lateral seta, the right palm marked laterally and medially with 2 strong spines and 1 long lateral seta. Palm slightly convex posteriorly, excavate anteriorly, with fine marginal cusps, left palm slightly oblique. Dactyl almost reaching the palmar corner, the right more slender than the left with 4 accessory spinules, sub-marginal on the lateral face, and a single dorsal spine at M0.2, the left with 3 facial spinules, and a 4th distal spine almost as an accessory tooth, and both lateral and medial sub-dorsal spines at M0.25 and 0.20. Left dactyl bearing distal nail, absent on right. *Second gnathopod* (Figure 2) dactyl without nail, bearing 3 inner accessory spines at M0.65-0.75, and a single small seta sub-marginal on the medial face at M0.4. Palm with 3 lateral and 3 medial stout trigger spines as well as 2 strong medial trigger spines and 2 long apically curved spines defining the palmar corner. Palmar length sub-equal to the free posterior length of the article. Free margin and corner of palm bearing long 'Hadziid' spines. Coxal plate broader than of G1, but still longer than broad, moderately setose both proximally and distally, otherwise naked. *Pereopods* (Figure 2). Coxae 3-4 with weak ventral setae, coxa 4 not excavate posteriorly, the posterior margin of article 6 of P3-4 armament formula S-s-S-s-S and S-S-S-Ss, P3-4 (89-80) smaller than P5-7 (98-115-170). Posterior margin of article 6 of P7 armament formula S-S-S-S-2S. Anterior spine sets of article 6, P7 not displaced by any keel like expansion. Coxae 5-7 bearing few setae on the ventral margin of the posterior lobes, article 2 moderately expanded bearing a small lobe on P6, moderate on P7, P7 bearing thin, short posterior setae. Dactyls of P3-7 bearing 2 or more distal accessory spinules; ie. 2 additional spinules as well as an outer basal penicillate setule. *Gills*. Coxae 2-6 each with a single flask-shaped gill. Gill 6 not reduced. *Oostegites* (Figure 2) of coxae 2-5 strap shaped, poorly setose. *Epimera* (Figure 3) 1-2 post-ventrally rounded, posteriorly convex, smooth, sparsely setulose. E1-3 with 0,1,2 ventro-facial spines. *Urosome* poorly armed dorsally. *Pleon*. Pleonite 1-6 with small dorsal setae in the formula 1-3-4-2-0-0. Dorso-lateral setae absent, pleonite 4 with 3 disto-ventral spines at the base of uropod 1. *Pleopods* (Figure 3). Retinacula 2 per pleopod, accessory retinacula variable; pleopod 1 with 2, pleopods 2-3 with 1. Basal articles of inner rami with paired, non-bifid setae, of outer rami, single setae. Rami extending sub-equally, outer with 10-11-10 articles, inner with 8-7-9 articles. *Uropods*. (Figure 3). *First uropod* peduncle length equal to length of inner ramus; medial margin bearing a row of 3 dorsal spines; mid-lateral row of 4 spines; single apico-

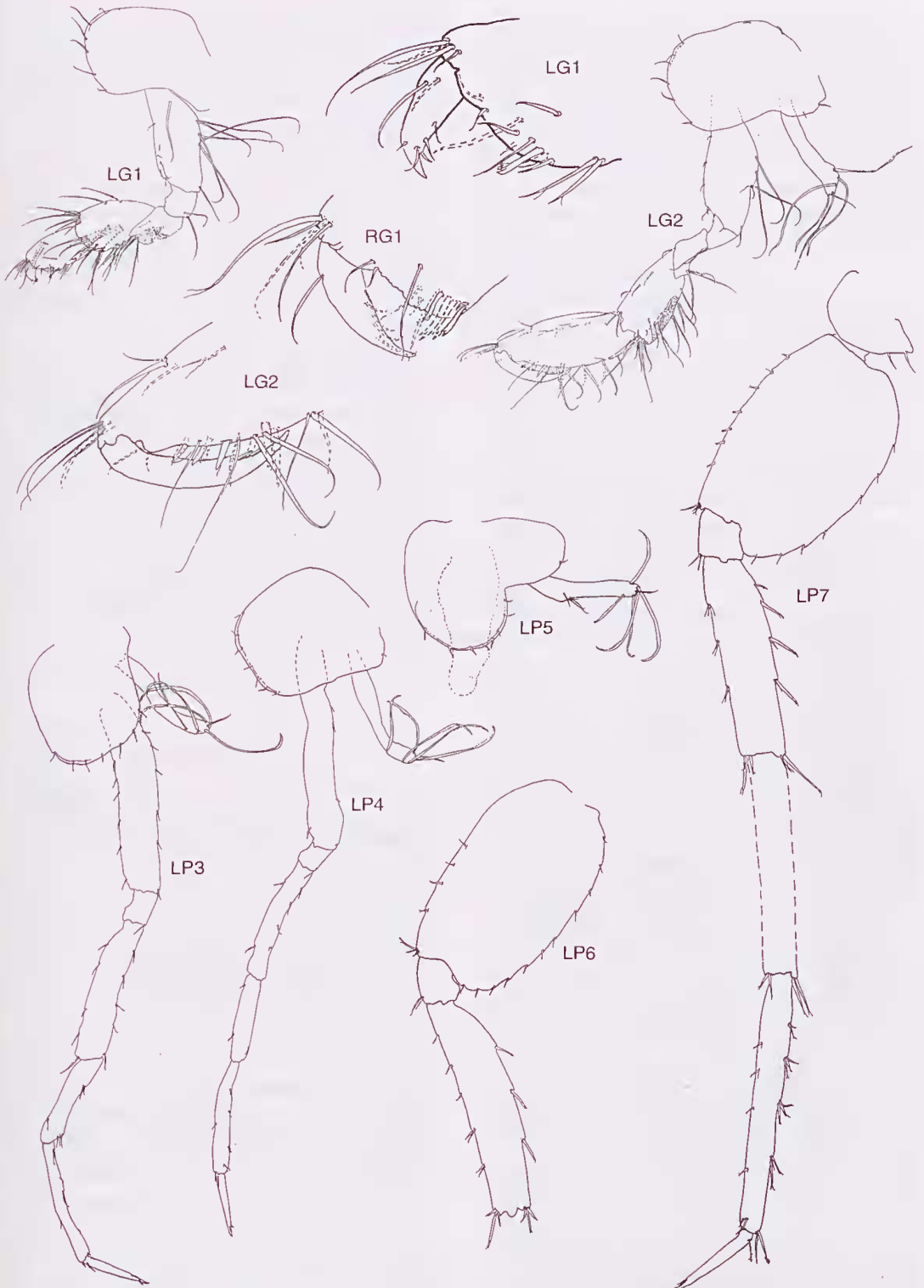


Figure 2 *Liagoceradocus subthalassicus* sp. nov., holotype, female 3.5 mm. Gnathopods and pereopods.

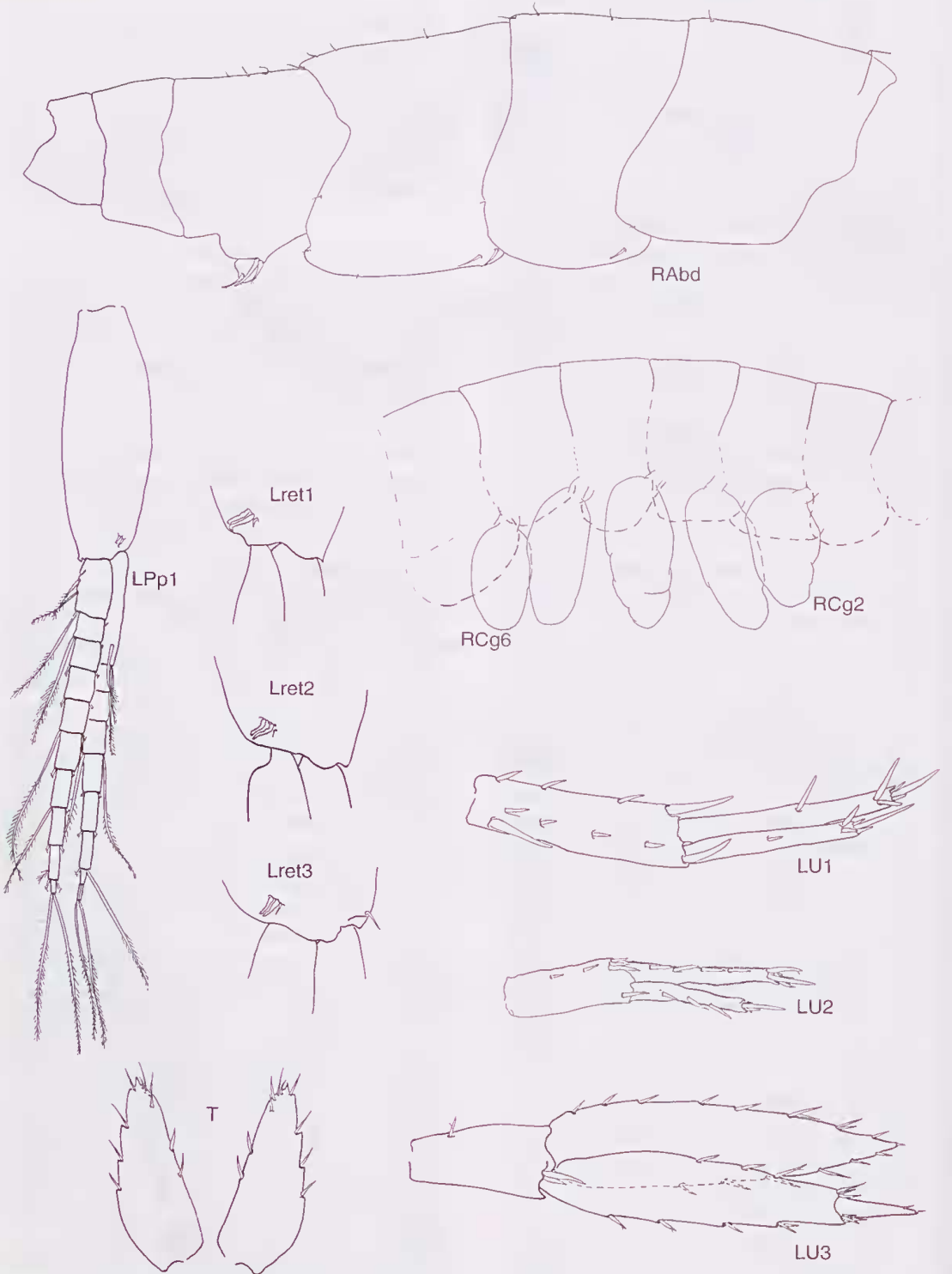


Figure 3 *Liagoceradocus subthalassicus* sp. nov., holotype, female 3.5 mm. Abdomen, gills, pleopods, uropods and telson.

lateral and apico-medial spines, prominent baso-facial spine. Rami unequal; inner ramus longer (90:75). Spine rows of rami reduced to a single dorsal spine on each, at M0.5, apices of rami each bearing 5 spines. *Second uropod* peduncle sub-equal in length to the shorter, outer ramus, bearing two dorso-medial spines at M0.4 and M0.7, a single dorsally displaced, sub-apical disto-lateral spine and 4 similarly arranged spines medially. Inner ramus longer than outer (77:58), outer ramus bearing a single row of 3 dorso-lateral spines and 4 terminal spines, inner ramus with a row of 4 dorso-medial spines and 5 terminal spines. Medial margin of peduncle and both margins of rami bearing small tooth spines. *Third uropod* magniramous, dispariramous. Peduncle short (60:160), with a single baso-medial seta at M0.3 and a pair of apico-dorsal spines. Outer ramus of 2 articles, proximal article bearing lateral and disto-medial marginal spines and clusters of 3 apical spines both laterally and medially; distal article shorter (35:125) with 2 medio-distal setae only. Inner ramus of one article, lanceolate, sub-equal in length to outer ramus, marginal spines evenly spaced, discontinuous basally on the lateral margin. *Telson* (Figure 3) 2.3x as long as wide, 2x urosomite 3, cleft 100%. Apices a rounded point, sub-apices notched bearing single medial and lateral short spines and 3 medial sub-marginal spines, 3 lateral and 2 medial spines marginal on each lobe. Penicillate setules absent.

Distribution

Barrow Island, Western Australia.

Relationship

Liagoceradocus subthalassicus shows some minor variation from the genus as originally described by Barnard (1965), but not from the generic characteristics of species assigned to the genus later or by Barnard and Barnard (1983). *L. subthalassicus* differs in the presence of rudimentary inner lobes of the lower lip, of palmar spines on the second gnathopod, and in having a greater number of D setae on the mandibular palp.

The new species differs from *L. pusillus* Barnard in the absence of 2 dorsal spines on urosomites 1–2, although pleonite 4 bears 3 small setae, in the presence of a very weak rostrum, larger lateral cephalic lobes, palmar spines on the second gnathopod, a shorter article 1 on the mandibular palp and an extra seta on the second article and 9 rather than 6 D setae of the third article, a degenerate molar seta, presence of small basal lobes to the lower lip, pubescence on the inner face of the inner plate of the second maxilliped, relatively larger and longer fifth article with a keel-like posterior lobe on the second gnathopod, moderate expansion of the second article of

pereopods 5–7 (on P6 this article is post-ventrally lobate), and the telson lacks penicillate setules.

Liagoceradocus subthalassicus differs from *L. lonomaka* Barnard, 1977 in possessing a slightly oblique left palm on the first gnathopod, palmar spines on the second gnathopod, a shorter first antenna, extremely short molar seta, 9 rather than 7 or 8 D setae on the third article of the mandibular palp, more slender third article of the maxillipedal palp which is also less spinous although facially pubescent with distal comb rows of setae, small basal inner lobes of the lower lip, and the third uropod more nearly magniramous.

Liagoceradocus lobiferus Stock and Iliffe, 1991 is similar to *L. lonomaka* except for an apically bulbous third article of the maxillipedal palp, more elongate and less lobate second article of the seventh pereopod. *L. unciferus* Stock and Iliffe, 1991 is similar to *L. lobiferus* except in the form of the gland cone of the third article of the second antenna, almost symmetrical palps of the first maxilla, lack of spines on the first urosomite, and the morphology of the male endopodite of the third pleopod. *L. subthalassicus* thus differs from *L. unciferus* in the form of the gland cone, being similar to *L. lobiferus*, and the asymmetry of the palps of the first maxilla, and from *L. lobiferus* in lacking spines on the first urosomite, having a shorter third article, longer accessory flagellum and greater number of aesthetascs – although of shorter length – on the first antenna. There is a rudimentary molar seta, the mandibular palp third article is longer and bears an extra E seta, the inner lobe of the first maxilla is more slender and triangular, bearing 13 L, 12 R plumose setae, the outer lobe with 6 L and 7 R denticulate distal spines and 1 small naked medio-distal spine on each, the palps bearing on the left 4 slender distal and 2 short sub-distal spines, on the right 4 + 1 robust spines. The outer lobe of the second maxilla bears many long distal setae, not, however, arranged in two discrete rows as in *L. lobiferus*, the inner lobe bears an oblique row of 14 setae, the maxillipedal palp article 3 is more slender, the dactyl more setate, the outer lobe of the maxilliped bearing two disto-medially placed, rather than five robust, medial spines, the medial margin is carved into acuminate sinuosities proximally, the left inner lobe with three distal, one sub-distal and one small sub-distal sub-marginal spines the right inner lobe with three distal and one sub-distal spines. The first gnathopod bears posteriorly on the second article six long apically curved setae and a single long straight seta, the same article of the second gnathopod with three long curved and two short setae borne on a small mid-marginal posterior keel like extension, the fifth article is lobate the lobe elongate and keel like, the setae of propodus being more marginal than in *L. lobiferus*, the palmar

corner is marked additionally by another two 'hadziid' setae, the palm and dactyl are more spinous, the dactyl lacking recumbent inner teeth. The oostegites bear more distal setae, urosomite one has three rather than two ventro-distal spines at the base of the first uropod, the peduncles of the first uropod are less spinous, the second article of the third uropod and telsonic lobes are more slender, the telson lacks penicillate setules.

Liagoceradocus subthalassicus is similar to *L. dentiferus* Ledoyer, 1982 in that the third article of the maxilliped is curved and the length less than twice the width, second and third coxal plates are longer than wide, and the palm of the second gnathopod bears both setae and spines. *L. subthalassicus* differs from *L. dentiferus* in the absence of proximal spines on the medial margins of the telsonic lobes, such spines being located in the distal half of the margin, the width of the fourth coxa is as great as the length, and the second article of pereopods 5 to 7 is post-ventrally lobate.

Liagoceradocus subthalassicus differs from *L. acutus* Andres, 1978 in the greater relative length of the third article of the peduncle of the first antenna, shorter flagellum with fewer articles and aesthetascs on both antennae, rudimentary inner lobes to the lower lip, on the mandible an extremely short molar seta, simple right lacinia mobilis, fewer setate accessory spines, short first article of the palp which bears an extra E seta on the third article, fewer denticulate spines on the outer lobe of the first maxilla which bears asymmetrical palps, fewer more robust setae in the oblique facial row of the second maxilla, the inner lobe of the maxilliped without a sub-distal oblique row of setae rather with a sparse sub-marginal facial row. The coxa and second article of the first gnathopod have fewer spines and setules, the palmar angle distinct on the right side only although marked by fewer spines, the palm is without spinules and with few setae. The coxa and second article of the second gnathopod are less armed, the lobe of article five is keel like, the palm bears two lateral and two medial spines, the palmar margin (of the female) is equal to the free posterior margin, coxae of pereopods 3 and 4 are equal, coxa four bearing a small posterior seta, article two of P5 is more expanded and ovate, and there are few armaments on any article. Pereopod 6, article one is equal to that of P5. Coxal gills 3-4 are largest, gill 6 smallest. The epimera are without an oblique ridge and bear few spines; E2-3 with 1-2 antero-sub-marginal spines, and the posterior corners of each is rounded rather than acuminate. The pleopods are without bifid spines. The first urosomite bears three ventro-distal spines at the base of the first uropod, the peduncle of the second uropod bears two apico-medial spines and a disto-medial group of four small spines, the outer ramus

has three dorso-facial rather than two medio-distal spines, the apex of the third uropod an additional sub-apical setule. The telson is lanceolate rather than ovate, bearing one rather than two disto-lateral spines and is without penicillate setules.

L. subthalassicus differs from *L. branchialis* in: the absence of a distinct posterior lobe on the carpus of the second gnathopod; reduced rather than moderate molar seta; a greater number of medial setae on the second and third articles of the mandibular palp; longitudinal rather than oblique row of medial plumose setae on the inner plate of the first maxilla; greater pubescence of the maxillae; denticulate rather than spinous apical setae on the L outer plate of maxilla 1; absence of a small post-ventral lobe on the second article of P5; three ventro-distal spines rather than a small, single seta on urosomite 1 at the base of U1; presence of accessory retinacula on pleopods 1-3; greater setation of U1-3; presence of lateral setation, but absence of penicillate setules on the telson which is not tumid laterally.

Etymology

Named for the nature of the type locality.

Liagoceradocus branchialis sp. nov

Figures 4-6

Material Examined

Holotype

♂ 'a' from sample BES 4282, body length 4.0 mm, Cave C-28, Cape Range peninsula, Western Australia, Australia (22°25'S, 113°46'E), 26 May 1995, in saline water, A.A. Poole, D. Warren (WAM 257-95).

Paratypes

1 ♂ 'b' from sample BES 4282, body length 3.5 mm, same data as holotype (WAM 272-95); 3 ♂ same data as holotype except 24 May 1995, body length 3-5 mm (WAM 273-95 to 275-95); 1 ♂, same data as holotype except 25 May 1995, body length 3.5 mm (WAM 256-95).

Type locality

Bundera Cenote, (C-28) below pycnocline in a tidal, almost anoxic, anchialine cave (22°25'S, 113°46'E) on North West Cape, Western Australia.

Diagnosis

Pereonites and *pleonites* bearing few fine dorsal and dorso-lateral setae, without carinations or teeth. *Head*. Rostrum weak, lateral cephalic lobes weakly projecting, antennal sinus small and distinct, eyes absent. *First antenna* elongate, longer than A2, ratio of peduncular articles 24:27:10,

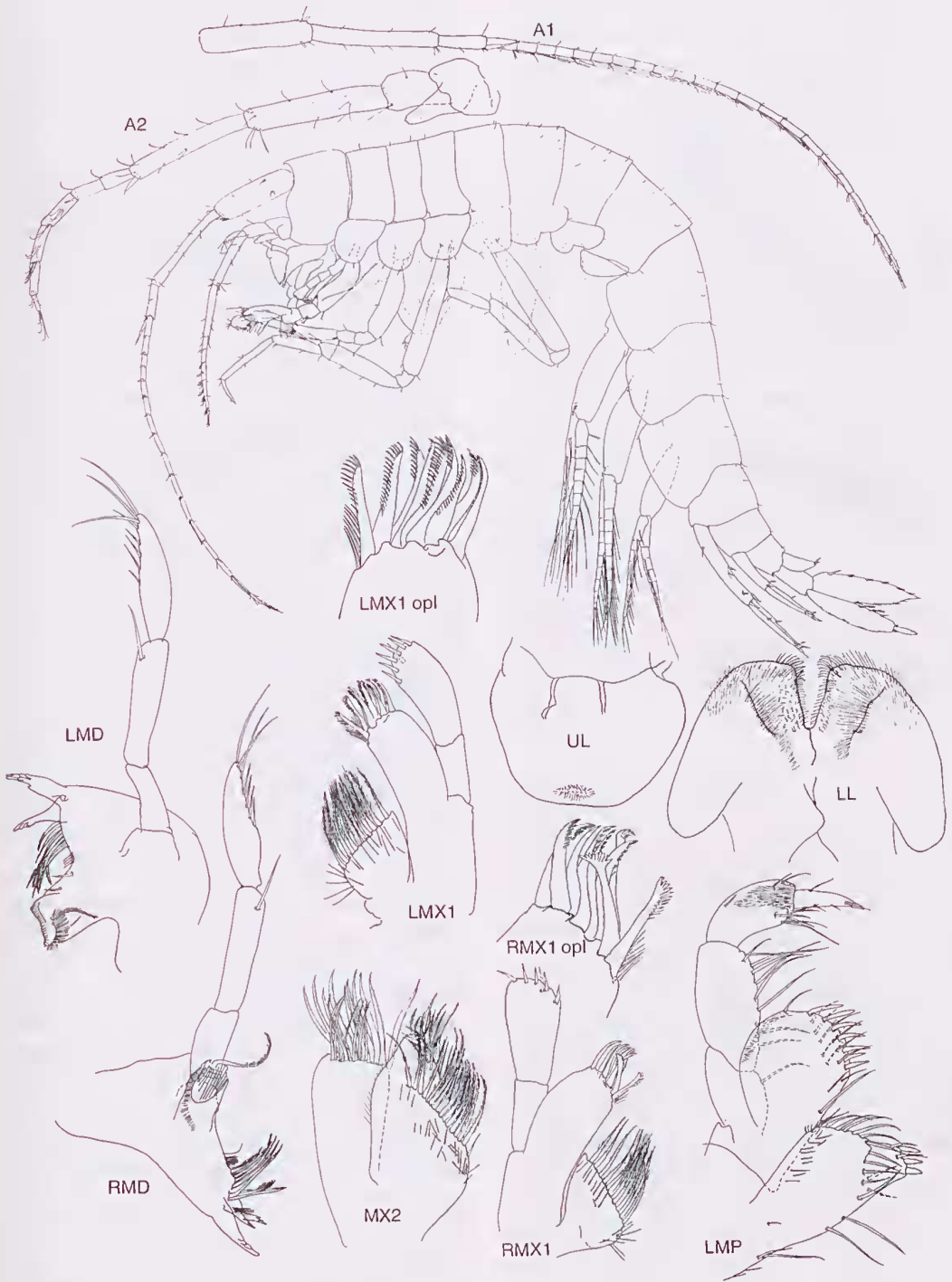


Figure 4 *Liagoceradocus branchialis* sp. nov., holotype, male 4.0 mm. Whole animal (male 'c' 3.5 mm), antennae and mouthparts.

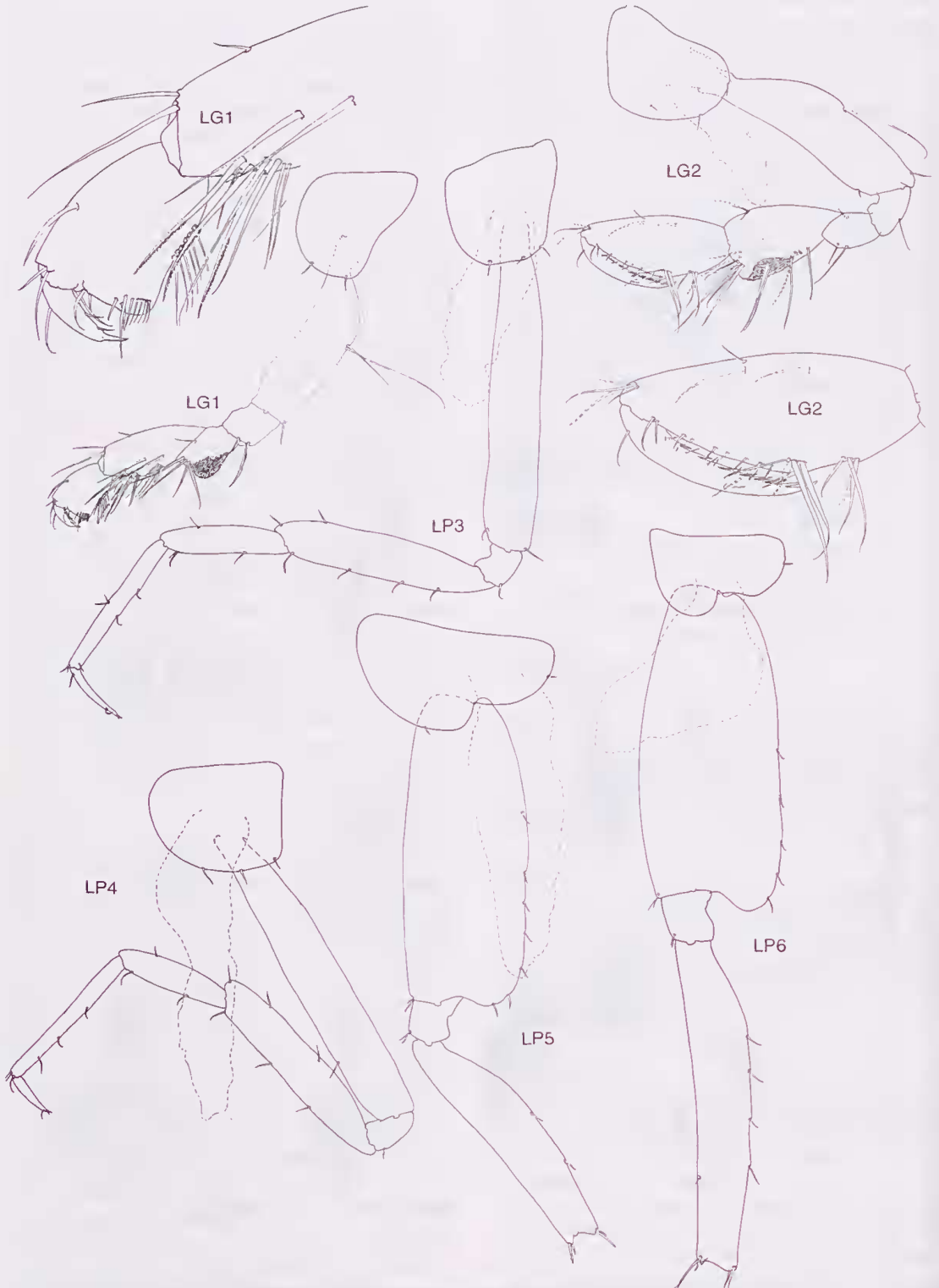


Figure 5 *Liagoceradocus branchialis* sp. nov., holotype, male 4.0 mm. Gnathopods and pereopods.

accessory flagellum 2 articulate, without calceoli. *Second antenna* short, flagellum much shorter than peduncle, calceoli absent. *Upper lip*. Apical margin rounded, symmetrical. *Mandible*. Palp 3 articulate, ratio of articles 1:2:2, article 1 not setose, article 2 bearing 1 strong medial seta, article 3 sub-falciform, setate, sub-equal in length to article 2, setae = D5,E3. Accessory blades (rakers) = 8L, 7R, with few inter-raker plumose setae and few additional setae leading to the base of the molar. *Lower lip* with rudimentary inner lobes. *Maxillae* sparsely setose medially. *First maxilla* inner plate triangular, the distal end linear, acute, bearing 10 plumose setae, outer plate with 9L spinous setae and 7R denticulate and spinous setae, palps asymmetric, inner plate sparsely pubescent. *Second maxilla* inner plate with oblique facial row of plumose setae, outer plate without pubescence, both plates with moderate and strong apical setae. *Maxilliped*. Inner plate long, extending beyond M0.5 of the outer plate, bearing sparse lateral pubescence, distally narrowed, and bearing three naked tooth spines and two moderately elongate naked setae, laterally and facially a row of long setae, and medially and baso-medially sparse setae. Outer plate broad, ovate with 7 curved naked apical and disto-medial spines without plumose distal setae, bearing submarginal, facial and ventro-facial slender setae. Palp article 2 without lateral setae, article 3 with a single sub-marginal lateral seta at M0.4, and 2 latero-facial setae at M0.8 and M0.9, article 2 moderately setose medially, article 3 bearing disto-facial pubescence, and a few elongate disto-medial setae basal to the dactyl, the apex not produced, dactyl unguiform with 2 distal accessory spinules, equal to the nail which is of moderate length, and bearing two accessory posterior spinules. *Coxae*. C1–2 longer than broad, C3–4 as broad as long, C1–4 without posterior spines, C1 not expanded below, C4 not excavate posteriorly. *Gnathopods* subchelate, 1–2 diverse. Setae of articles 4 ordinary, not rastellate. *First gnathopod* small, feeble, carpus longer than propodus, not lobate, merus lobate the lobe pubescent, palms transverse, palmar spines symmetrical, not bifid, without small sub-apical trigger like extensions. Spines at corner of palm absent, rather with an adjacent row of 7 slender setae. Few spines or setae along the palm, dactyls lacking recumbent inner tooth spines, but bearing 2 posterior accessory spines, and a pair of elongate setae arising adjacent the base. Dactylar nail present. *Second gnathopod* enlarged, 1.4x G1, carpus equal to propodus, with shallow, pubescent posterior lobe, posterior setae sub-marginal proximally, to facial distally, propodus ovate, palm oblique, moderately spinose, defining corner with 2 elongate 'hadziid' setae, 1 moderate medial seta and single lateral and medial bifid setae, posterior

margin bearing few long 'hadziid' setae (Barnard & Barnard, 1983). Dactyl bearing several recumbent inner tooth spines, nail absent. *Pereopods* slender, weak. P3–4 smaller, weaker than P5–(7), posterior spine sets on article 6 of P3–4 sparse, weak. P5–(7) moderately elongate, (P7 longest), P5 shortest, article 2 moderately expanded, ovate, slightly lobate on P5–6. Dactyls of P3–4 bearing 2 distal accessory spinules as well as an outer basal penicillate setule. *Gills*. Coxae 2–6 each with a large flask shaped gill. Gills 4–5 largest.

Epimera. Posteroventral tooth of E1–3 absent. Posterior margins smooth and naked except E2–3 with single, small posterior setae, E3 bearing a single, small antero-ventral seta. *Pleopods* similar each with 2 retinacula, without peduncular setae, and all plumose setae of rami simple. Rami extending sub-equally and symmetrically. *Urosome*. With a single, tiny ventro-distal spine on urosomite 1 at the base of U1. *Uropods*. U3 extended, magniramous, dispariramous, peduncle short, outer ramus 2 articulate. Apico-lateral and apico-medial corners of peduncles of U1–2 with 1 spine, the dorsal margins of U1 spinose, peduncle of U1 bearing a baso-facial spine. Rami sub-equal, the lateral being the shorter, rami of U1–2 with single spine rows, the medial margins of rami bearing fine setae. Rami of U3 bearing medial, lateral and apical setae. *Telson* shorter than broad, cleft 100%, lobes moderately tumid laterally, and medially, with sub-apical setation, medial and lateral setae virtually absent. Penicillate setules present sub-apically.

Description of holotype (male)

Body 4.0 mm. (Figure 4). Poorly armed dorsally. *Head*. Rostrum weak, lateral cephalic lobes weakly projecting, antennal sinus small, distinct, eyes absent. *First antenna* (Figure 4) length 0.6x body. Flagellum longer than peduncle – 1.9x (115:61) – peduncular article 1 shorter than article 2, bearing weak setae only, article 3 shortest (ratio of lengths; 24:27:10), with sparse setae, accessory flagellum 2 articulate, reaching M0.7 of article 1 of primary flagellum. Primary flagellum of 23 articles, article 1 elongate, 1.8x article 2, articles 2 to penultimate article progressively elongate and slender, most bearing aesthetascs, sparsely setulate, calceoli absent. *Second antenna* (Figure 4) length 0.2x body, peduncle longer than flagellum (65:35), gland cone well developed and extending to M0.7 of the third article, peduncular article 3 with few setae or spines, article 4 longer than article 5, both slender, moderately setulate. Flagellum 6 articulate, calceoli absent. *Upper lip* (Figure 4). Apical margin rounded, symmetrical, with a small terminal area of short pilia. *Lower lip* (Figure 4). Inner lobes small, rudimentary, indistinct. *Mandibles* (Figure 4). Asymmetric. Left mandible: palp article 1 shorter

than 2, articles 2-3 equal, article 2 bearing a single, strong moderately long medial seta at M0.8, article 3 with 5D and 3E setae, incisor 5 toothed, lacinia mobilis with 4 teeth, 8 setose accessory blades, 4 short and 2 moderately stout setae leading to the molar, molar triturative, with fine marginal setae, and bearing a papose distal seta. Right mandible palp article 3 bearing 4D and 3E setae, incisor 4 toothed, lacinia mobilis bifid, both articles denticulate, and bearing small, fine mid basal setae, 7 accessory blades and 1 interraker plumose seta, few additional fine setae lying between rakers and molar, molar similar to left mandible. *Maxillae* (Figure 4). Right and left *first maxillae* asymmetric; left palp with 6 facial, sub-terminal, stout setae and 1 on the ventral face, left outer plate bearing 9 stout setae armed with marginal spines, right palp bearing 5 slightly shorter terminal setae and 1 ventral seta, the right outer plate bearing 9 stout setae, some with marginal spines others strongly dentate, or with a mix of spines and denticles, the outer plate of both bearing an apico-medial cluster of fine setae basal to the first and second terminal spines. Inner plate with 10 distal plumose setae on both sides. *Second maxilla*: inner plate bearing sparse facial and lateral pubescence, outer plate naked. Pubescence of inner plate extending across the face basal to an oblique row of 15 plumose setae, medial margin slightly oblique bearing a medial marginal row of 7 slender naked setae, a distal sub-marginal row of plumose setae, and distal marginal row of mixed plumose setae and 2 stout rastellate setae. The outer plate without medial or lateral setae and apically a sub-marginal row of 7 slender naked setae and 10 long, stout rastellate setae. *Maxilliped* (Figure 1), Inner plate bearing few ventro-facial spines. *First gnathopod* (Figure 5) coxal plate with 2 short setae ventrally. Article 5 (carpus) not lobate, bearing strong posterior naked and rastellate setae. Propodus trapezoidal, expanding slightly apically, longer than wide (70:50), posterior margin bearing a row of 6 slender setae, the corner of the palm without lateral or medial spines, but a sub-distal row of 7 moderate, slender setae. Palm transverse, slightly convex posteriorly, with few adjacent setae, without marginal spination, or anterior excavation or marginal cusps. Dactyl reaching the palmar corner without recumbent inner tooth spines, but bearing 2 accessory spinules and a nail. *Second gnathopod* (Figure 5): larger than G1, the carpus posteriorly lobate and pubescent, bearing long, strong, apically curved setae, propodus ovate, palm strongly acute, dactyl extending beyond the corner defined by 2 long 'hadziid' setae and a slender seta laterally, and single lateral and medial bifid setae, palm bearing few short, simple setae, dactyl without a nail, bearing 7 recumbent, inner tooth spines and 5 sub-marginal, posterior,

accessory setae as well as a single small seta on the medial face at M0.6. Two moderate length spines arise from the propodus at the base of the dactyl. Coxal plate similar to G1, bearing 1 ventral, 1 antero-ventral, and 1 antero-facial setae. *Pereopods* (Figure 5). Coxae 3-4 each with 3 ventral setae, no posterior setae, coxa 4 not excavate posteriorly, the posterior margins of article 6 of P3-4 with few armaments; formulae S-S and S-S-S, P3-4 subequal, smaller than P5-(7). Coxa 5 bearing 1 antero-ventral seta, and coxae 5-7 bearing single setae on their posterior margins, article 2 moderately expanded bearing a small lobe on P5-6. Dactyls of P3-4 long and slender, bearing 2 distal accessory spinules; ie. 2 additional spinules as well as an outer basal penicillate setule. *Gills* of coxae 2-6 each with a large, single, flask shaped gill. Gill 5-6 largest. *Epimera* (Figure 6) 1-3 without posterior tooth, posteriorly convex to straight, smooth, without facial setae. E3 bearing a single antero-ventral seta, E1-2 each with a single posterior seta. *Urosome* poorly armed dorsally. *Pleon*. Pleonites 1-6 with few small dorsal setae, dorso-lateral setae largely absent, pleonite 4 with a single, small disto-ventral spine at the base of uropod 1. *Pleopods* (Figure 3): similar, retinacula 2 per pleopod, without accessory retinacula, peduncles without setae, rami extending sub-equally, without bifid or 'diamond head' setae; all setae similar, plumose. *Uropods*. (Figure 3). *First uropod* peduncle length greater than length of inner ramus; medial and lateral margins each bearing 2 setae, single apico-lateral and apico-medial spines, and a moderate baso-facial spine. Rami unequal; inner ramus longer (50:46), lateral ramus without setae except an apical group of 5, the medial ramus bearing a single medial seta and an apical group of 5 setae, the medial margins of both rami bearing a row of fine pubescence. *Second uropod* peduncle sub-equal in length to the shorter, outer ramus, without setae except for single lateral and medial apical setae. Inner ramus longer than outer (41:35), outer ramus bearing a lateral row of 2 setae at M0.6 and M0.7, and 4 terminal spines, the inner ramus with a single dorso-medial spine, and 5 terminal spines. Medial margins of both rami bearing small, pubescent setae. *Third uropod* magniramous, dispariramous. Peduncle much shorter than outer ramus (30:87), with a single small baso-medial seta, without any apical setae. Outer ramus of 2 articles, proximal article bearing 5 lateral, 2 plumose and 1 naked disto-medial marginal setae, and 1 and 2 apical spines respectively. The distal article short (18:70), with single, tiny medio-distal and apical setules. Inner ramus of one article, lanceolate, shorter than the outer ramus (80:87), marginal setae discontinuous basally on the lateral margin, 3 lateral and 6 medial setae, the baso-medial seta more robust, and a single tiny sub-apical, slightly

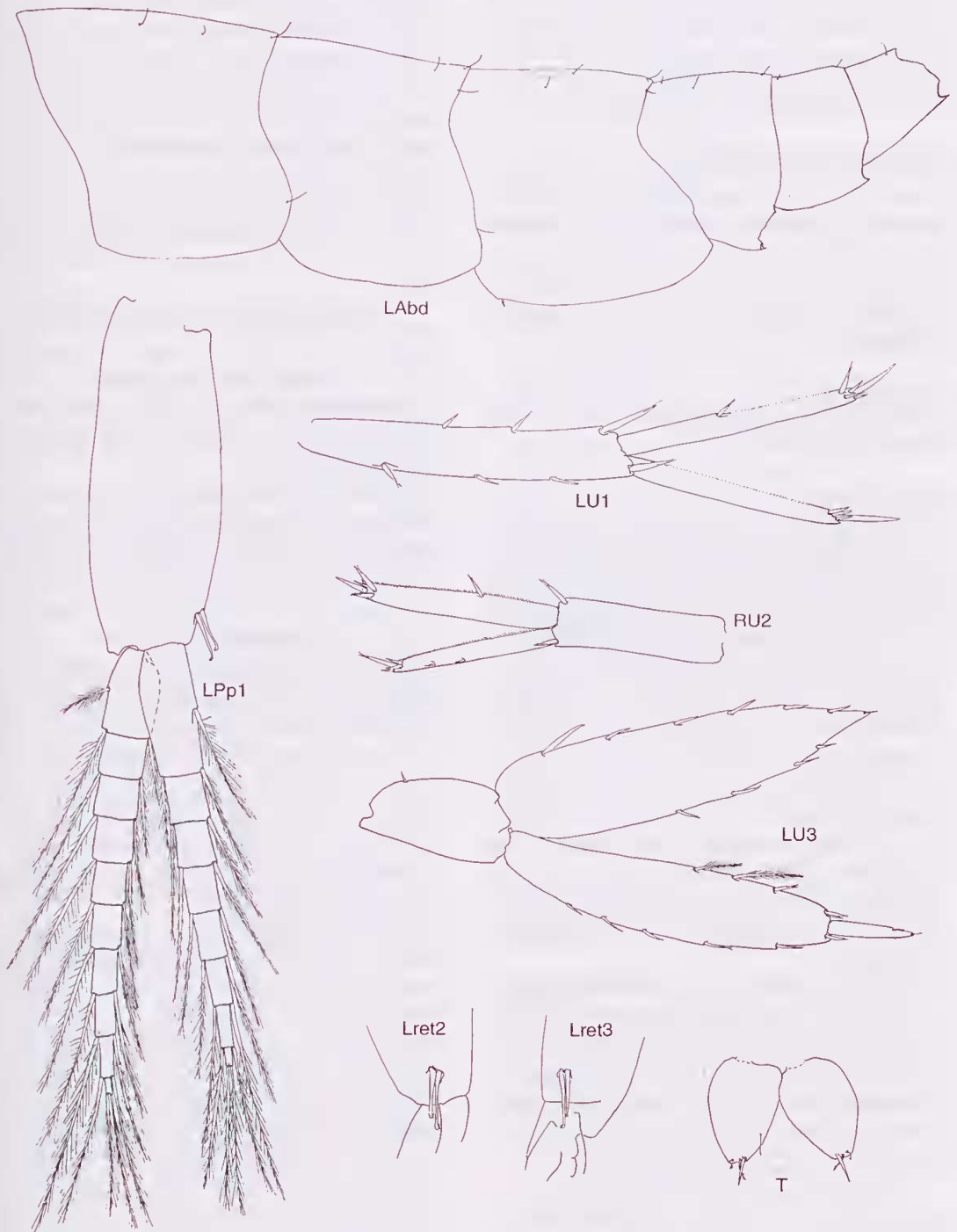


Figure 6 *Liagoceradocus branchialis* sp. nov., holotype, male 4.0 mm. Abdomen, pleopods and uropods.

medial setule. *Telson* (Figure 3) shorter than broad (45:63), sub-equal in length to urosomite 3, cleft 100%, laterally tumid, the apices rounded or slightly notched, bearing a moderately long single naked seta and 2 small penicillate setules, and on the left lobe a single sub-marginal medial seta at M0.7. Lateral penicillate setules absent.

Description of other material

Male 'c', 3.5 mm. A1 flagellum of 16 articles, aesthetascs present on articles 11, 14, 16; relative lengths of peduncular articles; 19:21:6 (compares with 24:27:10, converts to 24:27:8), length of flagellum relative to peduncle; 77:46 (compares with 115:61, converts to 115:68), and accessory flagellum reaching to end of article 1 of primary flagellum.

Distribution

Bundera Cenote (22°25'S, 113°46'E), North West Cape, Western Australia.

Relationship

Liagoceradocus branchialis, like other species assigned to the genus, differs from Barnard's (1965) original definition in minor ways. Rudimentary inner lobes are present on the lower lip, palmar setae are found on the second gnathopod, and there are 5 rather than 6 D setae on the third article of the mandibular palp, and which article is not longer than article 2. In keeping with the original definition of the genus the telson is deeply cleft, although, unlike in Barnard's revised (1977) concept, lateral setae (spines) are absent. *L. branchialis* differs also from *L. pusillus* Barnard in that the apex of the third maxillipedal palp article is not apically produced, the rostrum is reduced, but not entirely absent; the third epimeron is not acuminate; there are no dorsal spines on urosomites 1-2; sparse setae on the inner face of the inner plate of the second maxilla; post-ventral lobes on the second article of the fifth and sixth pereopods.

L. branchialis differs from *L. lonomaka* Barnard in the presence of a small rostrum; relatively shorter antennae; symmetric molarial setae; the third article of the maxillipedal palp is similarly armed but not as broad; the uropods are less setate, the peduncular spines of U2 are simple not forming a comb; the telson is without medial and lateral spines; the cuticle smooth, with few setae; the second article of P5 is broader than on P4.

L. branchialis differs from *L. acutus* Andres in the length of the A1 accessory flagellum which is relatively shorter; A2 is composed of peduncle and 6 rather than 14 flagellar articles, the gland cone is less tapered; the upper lip has less apical setation; mandibular palp article 3 has fewer D setae; the

inner lobe of the first maxilliped has fewer plumose setae; maxillipedal palp article 3 is not produced apically, and spines of the plates are naked, not setulate or rastellate; coxal plates bear fewer setae; G1 is without palmar corner spines, the palmar margin is without spinules or bifid spines; the legs are less setose or spinous; epimera are without an oblique ridge, the post ventral corners without teeth or acumination, ventral margins are without spines or setae; peduncles of pleopods bear 2 retinacula each without accessories, setae are all simple and plumose; basofacial spine of U1 is weak; peduncles and rami of uropods with fewer spines and setae; the telson is without lateral spines.

L. branchialis differs from *L. dentiferus* Ledoyer in that the second article of P5 is weakly lobate; the width of C4 is less than its depth; the palm of the second gnathopod has fewer spines or setae; telsonic lobes are without lateral or medial spines. The two are similar in that the third article of the maxillipedal palp is curved, and the dactyl bears accessory spinules.

L. branchialis differs from *L. unciferus* Stock and Iliffe in possessing a shorter A1 accessory flagellum, aesthetascs longer than flagellar segments; the gland cone of A2 is less pointed; fewer setae on articles 2-3 of the mandibular palp; less apical setae on the palp of the first maxilla; the G1 is without spines at the palmar corner, and without bifid spines; G2 dactyl bears larger recumbent inner tooth spines, there are fewer palmar spines, the palmar corner bears bifid rather than naked spines, as well as long 'hadzud' setae; coxae and Pereopods bear fewer marginal setae, coxa 4 is wider than long; epimeral plates 1-2 are post-ventrally rounded rather than pointed, without ventral setae or spines; pleopods are unmodified, similar, without bifid setae or accessory retinacula; uropods are less spinous; telson is without medial or lateral spines, with apical penicillate setules.

L. branchialis differs from *L. lobiferus* Stock and Iliffe; the body is similarly armed except for the absence of dorsolateral spines on urosomites 1-2; appendages are less spinous or setate; U3 is relatively longer; A1 peduncle article 2 is longer than article 1, the accessory flagellum is shorter than the first article of the primary flagellum, the primary flagellum has more articles but the same relative length, the aesthetascs are longer; A2 gland cone is broader and less pointed apically, the flagellum of similar numbers of articles; mandibular molar well developed, palps with fewer setae; first maxilla inner lobe with more plumose setae although similarly arranged, the processes of the spines of the outer plate are similar, the palps with fewer terminal spines; second maxilla bearing more setae both plumose

and rastellate; maxilliped article 3 not apically extended, the outer lobe ovate, not subquadrate, bearing 7 slender curved spines rather than 5 robust spines, the inner lobe pyriform with lateral, facial, medial setae and spines; propodus of G1 lacking spines at palmar corner and without bifid spines; palmar spines of G2 without triggers, dactyl bearing prominent recumbent inner tooth spines; coxal gills 4–5 largest, 1.5X gills of C1–2; pleopods simple without accessory retinacula, all setae plumose, not bifid; uropods with fewer setae and spines; telson without medial and lateral spines, with apical penicillate setules.

Etymology

Named for the presence of large coxal gills.

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